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Reports
Cossitt,
F. M.

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UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

JOSEPH C. KIRCHER, REGIONAL FORESTER

REGION 8

CULTURAL PRACTICES IN SOUTHERN FOREST NURSERIES

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By

F. M. COSSITT

October, 1938

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CULTURAL PRACTICES IN SOUTHERN FOREST NURSERIES

Introduction

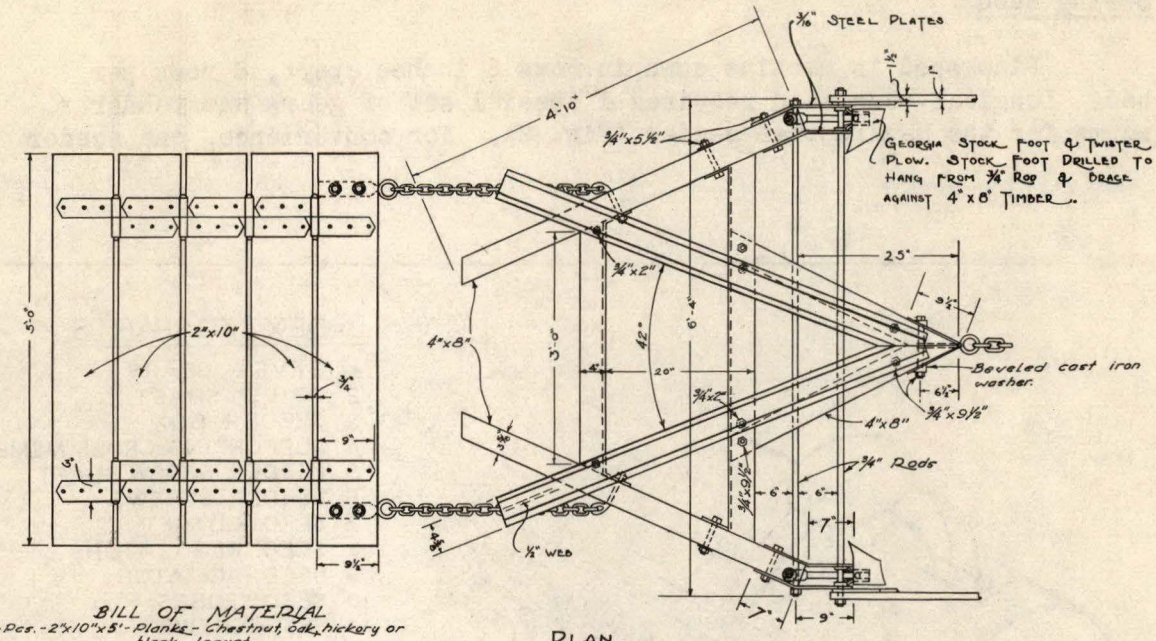
Production of large quantities of forest tree seedlings in the southern forest region has effected many changes in cultural methods employed at the nurseries. Hand work to prepare the beds, sow seed, weed, and pack for shipment has been reduced. Soil management has been greatly modified in ways calculated to maintain a satisfactory supply of plant nutriments. With the advent of mechanized equipment, application of repellents and sprays for the control of diseases, insects and rodents is no longer an expensive, time-consuming job. This paper presents the more important mechanical developments and related techniques used in Forest Service nurseries in the southern forest region.

Seedbeds - Size, Preparation, etc.

A seedbed area of 80 acres is needed for a nursery producing approximately 25,000 M 1-0 seedlings a year, half of which is planted annually to a legume soiling crop calculated to maintain soil fertility. One crop of seedlings, therefore, covers an area of 40 acres and requires the preparation and maintenance of 2,200 4 by 100-foot seedbeds. Sprinkler lines are 415 feet long, all ends of the lines terminating on compartment roads.

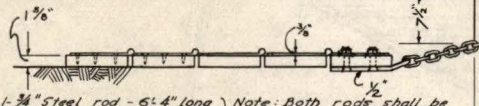
Initial ground preparation follows closely the best farming practice for the region. The soil is plowed quite deeply (8 to 9 inches), followed by double disking. A spiked-tooth harrow is often used behind the disk to level the area and pulverize the topsoil. Crawler-type tractors are the power units. Permanent terraces are not plowed, but are lightly disked.

A wide-gauged "50" Caterpillar and seedbed plow (Fig. 1) shape the seedbeds. A plow is attached to the seedling lifter frame from which the cutting blade has been removed. Path shovels throw the soil toward the center of the bed; a series of "V" drags smooth and level the bed surface. A float attached to the rear breaks the larger soil lumps and firms the soil. Men with garden rakes follow, pulverizing the soil and preparing the seedbed surface. The paths of seedbeds adjacent to the roads must be shaped by hand since only one-half of the paths are plowed in one trip, the others serving as guides for plowing the next beds.



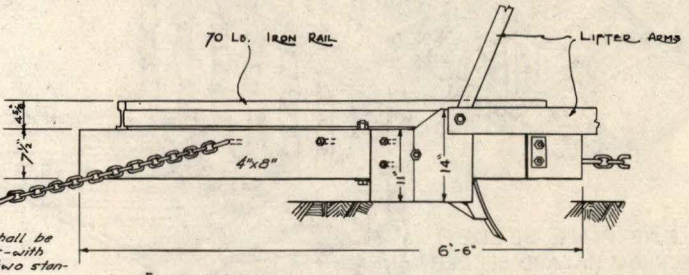
BILL OF MATERIAL

5-Pcs.-2"x10"x5'-Planks-Chestnut, oak, hickory or black locust.
1-Pc. -4"x8"x8' - Timbers
1-" 4"x8"x10'-"
2-Pcs-6:0" Long-70# Standard rail
1-Pc.-4"x4"x⅜"x5'-7"-Steel angle
1-" -4"x4"x⅜"x4'-0"-"
5-⅜"-Steel plates
4-Pr.-Heavy strap hinges-3"x9" Straps-Similar to #206-03-Richards-Wilcox Mf'g. Co, Aurora, Ill-General catalog #60.
4-⅜"x3½" bolts-with counter sunk heads
4-⅜"x6" bolts
6-¾"x9½" bolts
4-¾"x2" bolts
Note-All bolts shall have hex nuts and two standard washers each.
2-¾" Beveled cast iron washers.
6-Lin.ft.-½" standard coil chain

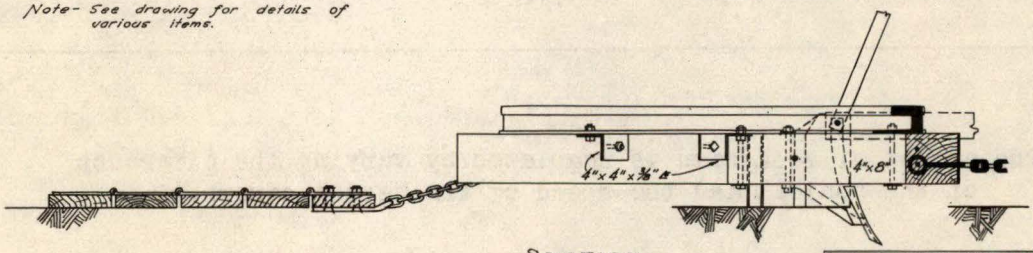


1-¾" Steel rod - 6'-4" long
1-¾" " " 6'-8"
Note: Both rods shall be threaded both ends-with two hex nuts and two standard washers
2-½"x3" eye straps-9½" long under eye one standard washer each.
2-¾" eye bolts-5" long under eye-with hex nut and one standard washer each.
2-Georgia stock foot and twister plows.

Note-See drawing for details of various items.



ELEVATION



SECTION

SCALE 1" = 1'-0"

ALL PARTS SECURELY BOLTED TOGETHER WITH ½" MACHINE BOLTS
DED PLOW IS PULLED BY WIDE GUAGE CATERPILLAR WITH LIFTING APPARATUS ATTACHED.

FIG. 1

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
REGION 8 R.E. PIDGEON REGIONAL ENGR.

THE W.W. ASHE NURSERY
SEEDBED PLOW

DESIGNED- DRAWN- K.G.C. TRACED-
SCALE- 1"=1'-0" CHECKED- DEPT.
APPROVED- DATE- 7/1/38
SHEET 1 OF 1 DWG. M-3901

Sowing Seed

Pine seed is machine sown in rows 6 inches apart, 8 rows per bed. Longleaf pine seed requires a special set of gears and feeder worms for the Hazard tree seeder (Fig. 2). For convenience, one seeder

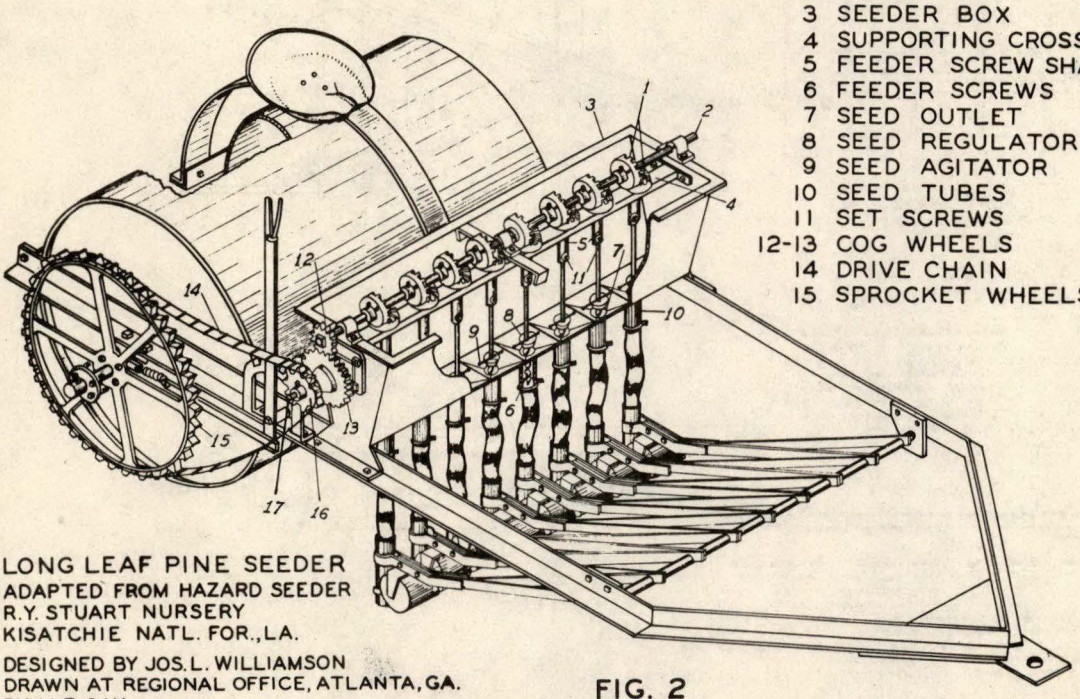


FIG. 2

Note: The amount of seed sown is regulated by varying the clearance of the conical and the speed of the feeder screws.

Special care must be exercised in adjusting both seeders to sow a predetermined amount per unit of area. This is done in the shop by turning the rear drum a known distance, then measuring the amount of seed from each drill. This drum, with a circumference of exactly 10 feet, permits ready calculation of the amount of seed dropped in a given distance. The amount of seed to be sown per unit of area depends upon the species, the density desired, and the quality of seed of each lot as determined by germination tests. The following quantities of each species per 400 square foot bed were sown in 1937:

Pine Species	Minimum Pounds	Maximum Pounds	Density Desired per Square Foot
Longleaf	5.1	11.6	25 - 30
Slash	2.2	3.9	30 - 35
Loblolly	2.2	3.2	30 - 35
Shortleaf	1.3	2.5	30 - 35

Machinery used in sowing consists of a wide-gauged, low-geered truck, locally known as a "Go-devil", a Hazard seeder, and a burlap cart. The latter is attached behind the seeder for use in spreading burlap over the beds as sowing progresses - all in one operation. Crew organization consists of a truck driver, one man on the seeder, one on the burlap cart, and six men pinning burlap to the seedbeds as it is spread. Two men keep the crew supplied with pins, burlap, and seed, which are picked up at the compartment roads as needed.

The burlap spreader is a two-wheeled cart which carries the burlap and from which it is fed over one roller and under another to the seedbeds (Fig. 3).

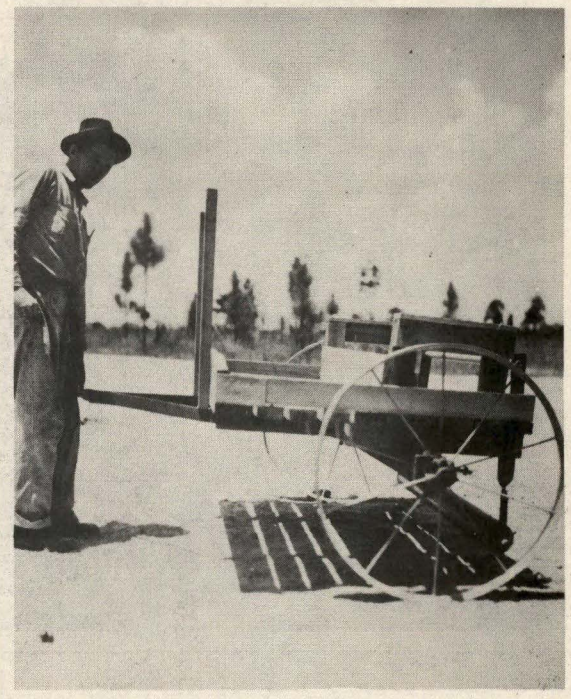


Figure 3

BURLAP LAYING CART

Such jobs as sowing, cultivating, spraying, and erecting and dismounting sprinkler lines call for the use of a wide-gauged power unit, and the "Go-devil" (one of the most valuable pieces of equipment around the nursery) has filled this need (Fig. 4). It was made by dismantling a Dodge 1½-ton truck, leaving only the motor and frame. The drive shaft was shortened to 3 inches and the differential assembly was attached directly to the frame. A chain drive hookup with small sprocket gears on each hub and large sprocket gears on the rear wheels reduced the speed of the machine to about 1 mile per hour in low gear. The rear springs were moved forward and the frame was reduced to 12 feet over all. Front and rear wheels were set on 72-inch centers. The front axle was made from 60-pound railroad steel, the rear axle from 3-inch diameter, rolled steel bar. Motor patrol grader tires were used on the rear wheels and ordinary 1½-ton truck tires on the front wheels.

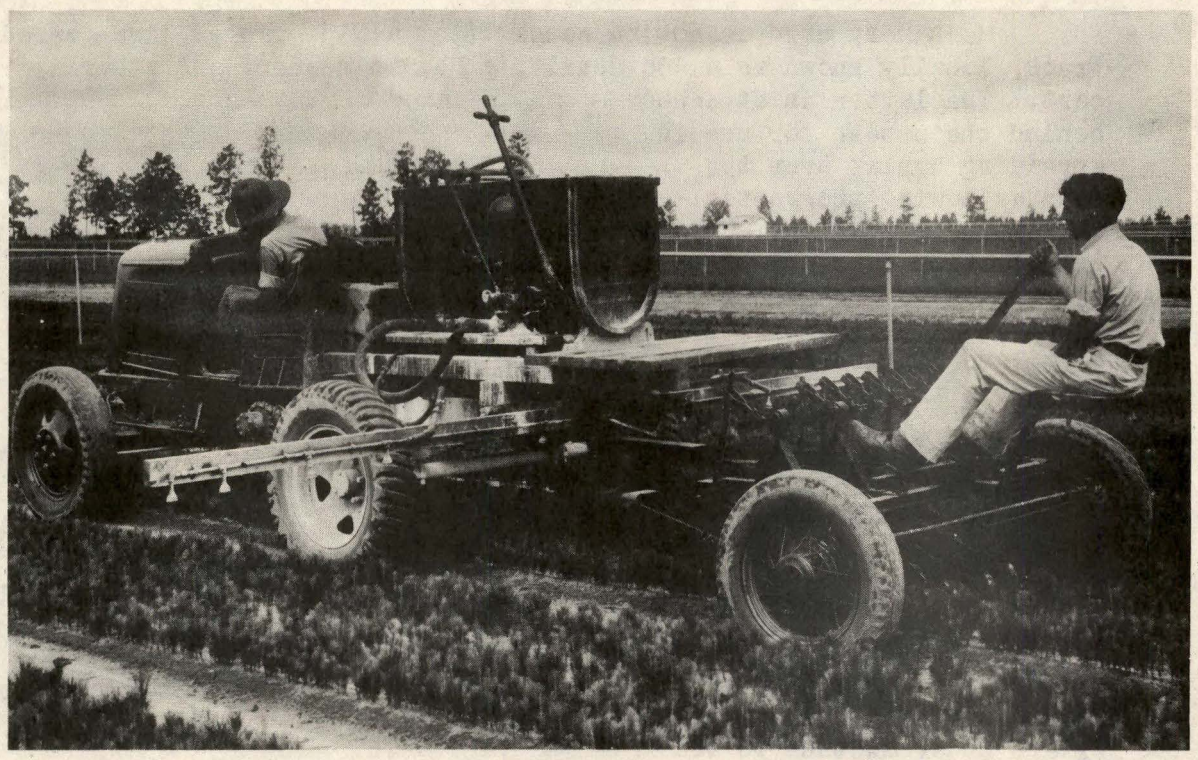


Figure 4.

Go-devil with Spray Mounted and Cultivator Attached

The attachment for the Hazard seeder permits sowing of longleaf pine seed. It consists of a set of ratchet gears which operate a feeder worm in each drill. Regular gears used for other pine seed were too small to permit longleaf pine seed to pass through without crushing. The sprocket wheel and drive chain on the side of the rear drum actuate the feeder worms.

Mulching

Eight-ounce burlap is used for mulching all pine seedbeds. Used in strips up to 100 feet long and 54 inches wide, it is kept in place with 12-inch No. 9 wire pins. These are spaced about 5 feet apart on both edges and the burlap remains in place until the seed has germinated. Frequently, a given lot of seed will show evidence of partial delayed germination, with the result that some seedlings are just emerging from the ground when others are ready to have the burlap removed. This condition calls for careful judgment by the nurseryman as to when to remove the burlap to secure a maximum stand. The period that burlap is left on seedbeds varies with the season, the soil, the species, and with individual lots of seed. The following data are taken from the 1937 nursery reports:

Number of Days Burlap Remained on Seedbeds

Pine Species	Maximum	Minimum
Longleaf	57	21
Slash	53	13
Shortleaf	48	17
Loblolly	47	17

After the burlap is removed, it is dried, cleaned, rolled, and stored in a dry place for future use. If carefully handled, burlap will last three years.

Cultural Practices

A mechanical cultivator has been developed at the nurseries, primarily to reduce weeding costs (Fig. 5). It is designed to cover the width of one seedbed. The operator guides the shovels between drill rows, and since the rows are always parallel and 6 inches apart, it is relatively easy to cultivate a bed without damage to seedlings. Cultivator shovels cover a 3-inch strip between each drill row, reducing by one-half the area to be hand weeded. The machine has been used two seasons at one nursery and one season at another. The "Go-devil" is used as a power unit.

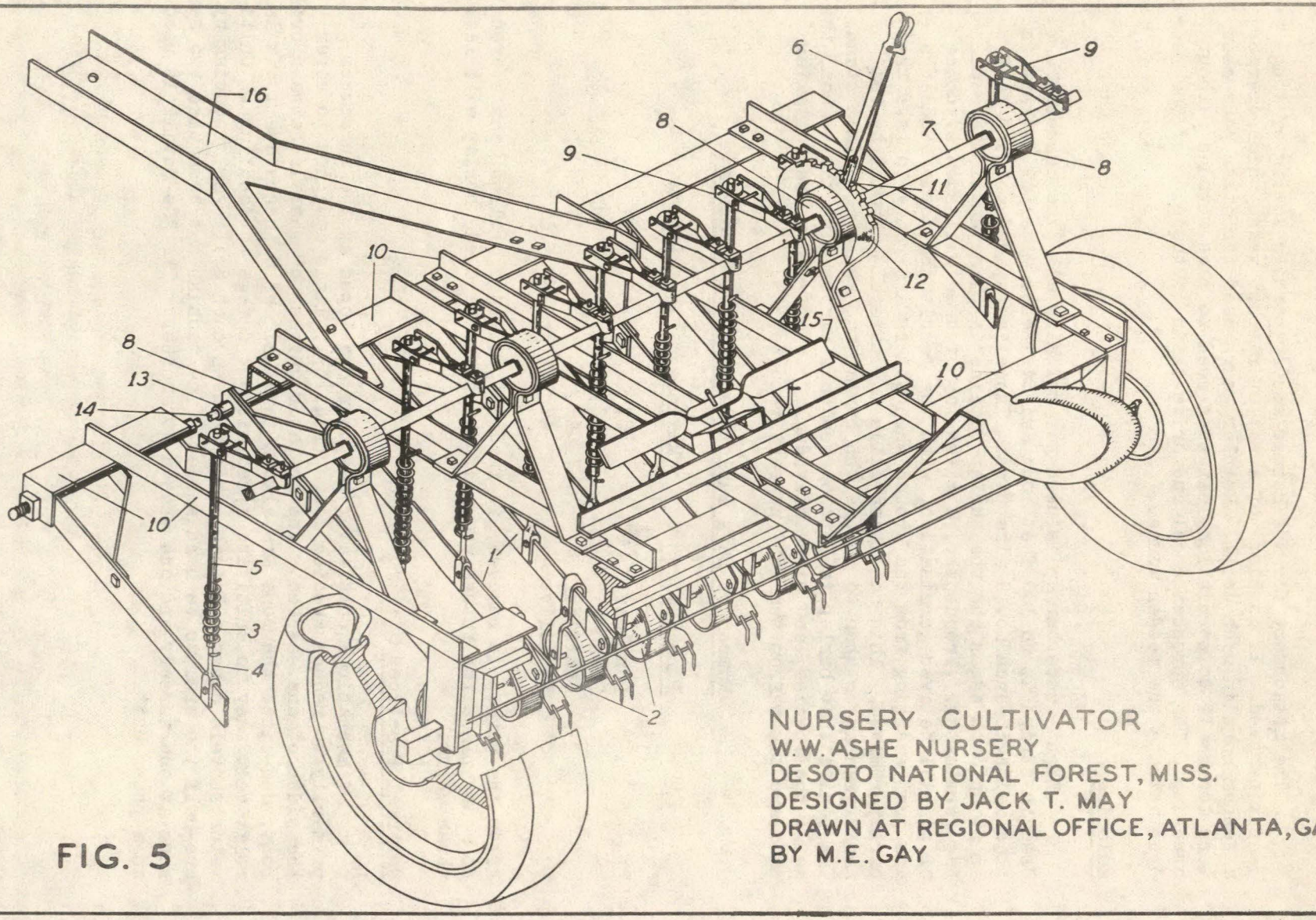


FIG. 5

NURSERY CULTIVATOR
W.W. ASHE NURSERY
DESOTO NATIONAL FOREST, MISS.
DESIGNED BY JACK T. MAY
DRAWN AT REGIONAL OFFICE, ATLANTA, GA.
BY M.E. GAY

CULTIVATOR SPECIFICATIONS

1. Cultivator arms
2. Depth wheels
3. Compression spring
4. Sleeve connecting rod
5. Outer sleeve
6. Cultivating shovel lever
7. Cultivator yoke shaft
8. Shaft bearing
9. Yoke
10. Frame
11-12. Dog and sprocket
13. Cultivator arm sleeve
14. Cultivator arm rod
15. Foot pedal
16. Tongue

Note: The machine is guided by operating the pedal bar which is attached to a model-T Ford automobile steering post, housing steering arm, drag link on an extended Chevrolet automobile tie rod and two steering arms attached to Chevrolet spindles; Chevrolet truck wheels are used.

Water Requirements

Amount and frequency of watering depend entirely upon rainfall during the growing period. During germination, light sprinklings are needed to keep the surface moist. Subsequent to germination, the beds are kept moist, and as the roots penetrate to greater depths, water is applied less frequently. In September and October, water is applied very sparingly, if at all, in an effort to inhibit late top growth. The number of waterings during 1937 varied from 5 at W. W. Ashe Nursery, Mississippi, to 48 at Ozark Nursery, Arkansas, where summer rainfall is considerably less.

It is sometimes necessary to water soiling crops, particularly when a second crop is sown in July. A drought of two weeks or longer is not unusual, and seed planted in dry surface soil does not germinate readily. A large portable sprinkler is used to moisten the surface, insuring prompt germination and subsequent growth. A larger volume of green manure is secured in this manner.

Control of Disease, Insects and Pests

Frequent sprayings with Bordeaux Mixture are required for control of brown spot and other diseases. A 4-4-50 mixture is used with whale

oil as a sticker. Four to six complete sprayings are needed after the burlap is lifted. The last application is made just prior to lifting and is intended to prevent early infection when stock is planted in the field. Spray is applied with a modified Meyers outfit mounted on the "Go-devil". This outfit consists of a tank, agitator, power pump, and a 3-bed spray boom attached to the rear of the truck. The pump is operated from the truck motor by means of a power take-off similar to that used on dumpbed trucks.

A rezl compound repellent spray, calculated to reduce rabbit damage, is applied to slash pine prior to lifting. A high-pressure spray gun outfit is mounted on the "Go-devil". Extra-long hose from the air and solution tanks, which allows the operator to walk behind the truck and spray the seedlings, is used. A roller, attached to the rear of the truck, bends the seedlings as it passes, permitting spray to be applied to the stems. Spraying seedlings from the top does not give complete coverage and is ineffective against severing of the stems by rabbits an inch or so above the ground (Fig. 6).

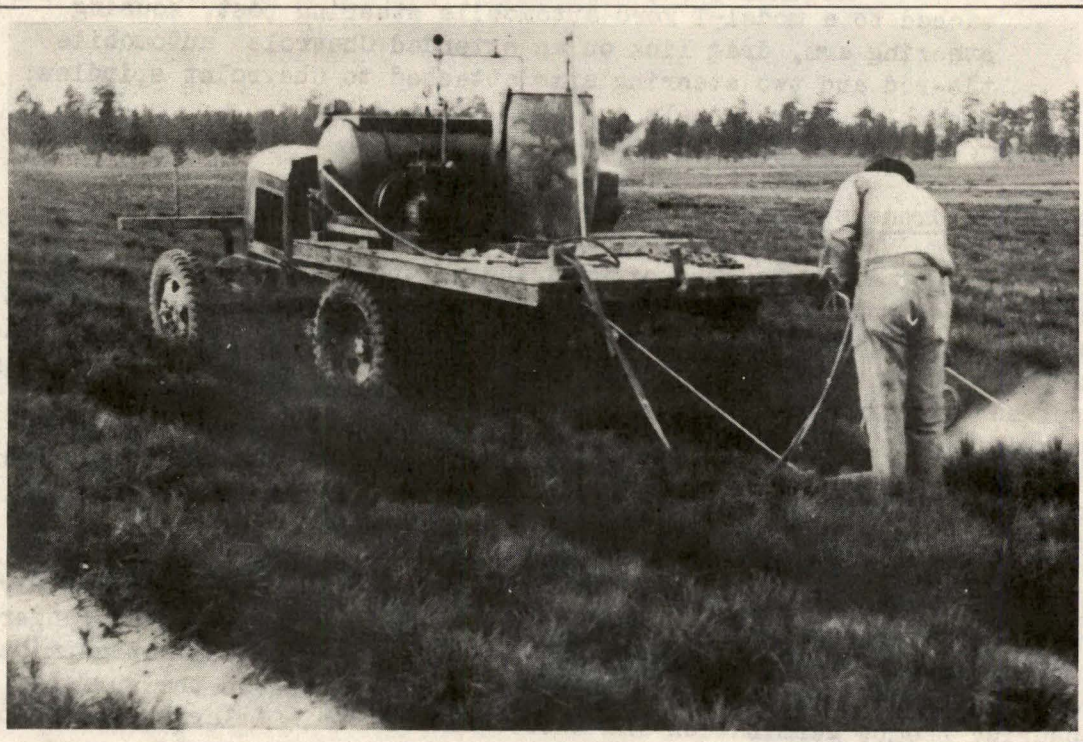


Figure 6.

SPRAYING SLASH PINE WITH RABBIT REPELLENT

A small gasoline motor and air compressor outlet furnish air for the gun. The spray formula that follows is recommended by the Biological Survey:

(A)	Chloroform	96 oz.	
	Strychnine	15 oz.	(Dissolve the strychnine)
(B)	Rezl #53	8 oz.	
	Chloroform	16 oz.	

Add (A) to (B), mix well, and add 1 ounce aluminum flakes for a tracer. This is sufficient spray for 30,000 trees. Other sprays are being tested to find a substitute which will be more effective and less expensive.

Control of rust canker diseases (Cronartium fusiforme and C. cerebrum) in the nursery is being attempted by the liberal use of Bordeaux Mixture during the infection period. All oaks for a distance of 1/4 mile have been cut or pulled to prevent the spread of spores to seedling pines. In addition, all infected pine has been removed to keep the stock disease free. The success of these measures remains to be proved, but it is expected that disease-free trees can be grown.

Harvester ants and white grubs have caused a small amount of damage. Subsoil brought up by the ants in the course of excavating new nests and galleries covers the small seedlings. Cyanogas "A" fumigant inserted in the nests through a probe hole is used as an insecticide, with fairly good results. The white grub population was greatly reduced by treating the infested areas with carbon disulphide emulsion through probe holes about 6 inches deep.

Soil Management - Cover and Soiling Crops

Soil management is one of the most vital nursery problems. In common with farmlands of the South, forest tree nurseries are subject to severe erosion. Mangum terraces have been constructed on all seedbed areas in a positive effort to reduce soil movement to a minimum (Fig. 7).

Figure 7.

MANGUM TERRACES - FALL-SOWN LONGLEAF PINE BEDS

Terrace outlets are located along compartment roads and empty into sodded road ditches or culverts, which lead water from the nursery area with the least amount of damage. The vertical interval has been held to a minimum, thus reducing the distance water travels before changing direction.

A winter cover crop of Hungarian vetch (Fig. 8), Austrian winter peas, or hairy vetch is sown about October after turning under the summer soiling crop for prevention of soil movement during the winter and spring months previous to seedbed preparation. Additional

tests are necessary before a definite choice of species can be made, but any one of the three will accomplish the desired objective.

Figure 8.

WINTER COVER CROP OF VETCH

The main soiling crop is sown late in April or early in May. Velvet beans are proving to be the most satisfactory because of the volume of dry weight material secured in a single crop. Cowpeas have been used with good results, but require two crops a year. Between 7 and 10 tons of dry weight material are added to the soil each year by the use of either of these legumes. Commercial fertilizer, either 4-8-4 or 6-10-7, is used at the rate of 350 to 400 pounds per acre to secure the maximum amount of green manure for turning back into the soil.

Velvet beans are cultivated until the ground is completely shaded. This is desirable because weed growth matures with the soiling crop. Much less weeding of a tree crop is required following a crop of beans when the ground is kept clean of undesirable plant growth An Ariens rototiller is used for the most part as a weeder in areas sown to cover crops and is supplemented by hand hoeing in the rows. The "Go-devil" and seedling cultivator are also used. After the vines cover the ground and prevent further machine cultivation, the few weeds left are pulled or cut by hand. The cost of weeding soiling crops is apparently justified in decreased cost of weeding seedbeds.

Additional humus is required for certain soil types. Where previous tree crops have not developed satisfactorily, often because of the lack of humus, the deficiency may be remedied as follows: A compost pile, consisting of rice straw, water and a reagent, is prepared and left for 8 to 10 months. The resulting compost is spread over the soiling crop area and turned under. It is expected that the additional humus so furnished will create better soil conditions for subsequent crops. The following reagent is used:

Ammonium Sulphate	45 per cent
Rock Phosphate (ground to pass a 200-mesh seive)	23 per cent
Finely-ground limestone	32 per cent

About 500 gallons of water and 150 pounds of the reagent are added per ton of dry weight material. More water is added as required to keep the pile moist at all times.

It is not expected that there will be adverse reactions in soil ph. as the result of using the compost, followed by a soiling crop. Temporary changes might occur, but will reach an equilibrium prior to the tree crop. Additional tests are under way to determine acidity by the use of compost.

Inventories

Field planting of forest tree seedlings begins in late November, and for proper planting it is essential that an accurate estimate of the amount of stock on hand be available. Movement of men from one camp to another, allocation of specific areas for given lots of stock, and other details, are based on this estimate. Wide variations between estimates and number of seedlings shipped cause considerable confusion and are sometimes expensive. It is, therefore, highly desirable that an estimate - accurate within 5 per cent - be available by October 10. It is made in the following manner:

1. All trees are counted on randomly-selected 1 by 4 foot plots amounting to about 1 per cent of the seedbed area. Distribution of the sample over the nursery will vary with the size of the seed lot and uniformity of density.

2. A small percentage of trees on the sample plots is dug and graded into plantable and cull. This varies from 1/50 to 1/25 of 1 per cent, dependent on the size of the lot and actual field conditions.

3. The data obtained are plotted on cross-section paper and curves are drawn for each species from which the actual number of plantable trees per density is read. With the known densities in the nursery, as taken from the counts and the actual area in seedbeds, an acceptable estimate of the number of plantable trees is obtained.

The method described lends itself readily to use by men not fully qualified to grade stock judged by top growth only. It is comparatively easy to secure an accurate count, but errors in grading are not compensating; hence an unreliable estimate of plantable stock often results. Additional data in subsequent years may be added and in time a more reliable curve may be secured.

An actual count of the seedlings lifted from a given number of beds in the nurseries indicated that estimates were correct within 2 per cent - well within the desired limit of error. It is expected that sufficiently accurate estimates can be secured to eliminate the necessity for additional counts at the time of lifting.

One grade of stock is used in Forest Service planting except in a few cases where site conditions demand superior seedlings. Minimum plantable grades depend on the caliper of the seedlings, height of the top, length of root, needle condition, and the succulency of the plant. Stock is lifted when 8 to 10 months old, and with a more or less irregular germination, a part of the stock is often only partially developed. The stem of immature stock is soft, with a high moisture content, and secondary needles are absent, or only partially developed, indicating a more or less weak plant which would not stand transplanting. Such trees are considered as culls. Frequently, root development is scanty, there being only a short taproot with a few partially-developed laterals. This also culls a tree despite the fact that top growth is entirely satisfactory. Drought during the early life of plantations may create moisture deficiency in the topsoil, and with roots confined to this horizon, the chances for survival decrease rapidly. Hence, only well-developed seedlings with thrifty tops, well-developed stems, and adequate root systems are used.

Stock Distribution

Lifting, grading, and packing stock for shipment constitute one of the largest jobs at the nurseries and require more manpower than any other operation in the same period of time. Coordinated action is necessary throughout the entire planting operation. Elapsed time between lifting and planting in the field is kept to a minimum, averaging slightly under 48 hours for the majority of the stock.

SPECIFICATION FOR 1-0 PLANTING STOCK FREE FROM MECHANICAL INJURY

Grade No.	Height* (inch)	Stem Diameter at Root Collar (inch)	Needles	Winter Buds	Bark
			LONGLEAF PINE		
1	Not less than 12 secondary needle length.	Not less than 1/2.	Abundant. Almost all in 3's or 2's	Usually present with scales.	
2	Not less than 8 secondary needle length.	Not less than 3/16.	Moderately abundant. At least part in 3's or 2's	Partially developed.	
			SLASH PINE		
1	Not less than 6.	Not less than 3/16. Stiff; woody.	Almost entirely in 3's and 2's.	Usually present.	Usually on entire stem.
2	Not less than 6.	Not less than 1/8. Moderately stout to stout and woody.	Part, at least, in 3's and 2's.	Occasionally present.	Moderately developed.
2-a	Not less than 4.	Same as above.	Same as above.	Well developed.	Same as above.
			LOBLOLLY PINE		
1	Not less than 6.	Not less than 3/16. Stiff; woody.	Almost entirely in 3's.	Usually present.	Usually on entire stem.
2	Not less than 4.	Not less than 1/8. Moderately stout and woody.	Part, at least, in 3's and 2's	Occasionally present.	Moderately developed on lower portion.
2-a	Not less than 4.	Same as above.	Same as above	Well developed.	Same as above.
			SHORTLEAF PINE		
1	Not less than 5.	Not less than 3/16. Stiff; woody.	Almost entirely in 3's and 2's.	Usually present.	Usually on entire stem.
2	Not less than 4.	More than 1/8. Moderately stout to stout and woody.	Part, at least, in 3's and 2's.	Occasionally present.	
2-a	Not less than 3.	Same as above.	Same as above.	Well developed.	

* Needle length is given for longleaf pine, stem length for other species. All roots should be at least [illegible]ches in length.

The wide-gauged tractor with lifter (Figs. 9 and 10) is used to loosen the seedlings in the beds. A crew of 6 to 12 men follow the lifter, bunching the stock and temporarily heeling it in along the outer edges of the bed. The seedlings are then taken to the packing shed where they are separated and fed over a grading table (Fig. 11). This table is equipped with two traveling belts and as the stock moves along in front of the graders on both sides of the table, culls and damaged trees are thrown out. Seedlings are so placed that root collars lie at a given point on the belt and as the stock leaves the table, the roots pass through a cutter which prunes them to a uniform length. At the end of the table, the stock is picked up and baled. The table has been used for a part of one season, but has proved effective in reducing grading and root pruning costs.

A framing table, similar to the Savenac baler, is used to frame bales. The frame is lined with a piece of waterproof burlap 24 inches wide and 6 feet long. Roots are overlapped in the center of the burlap and packed in sphagnum moss, tops extending toward the open ends. A 2-inch slat, top and bottom, with two flat metal straps, completes the bale (Fig. 12).

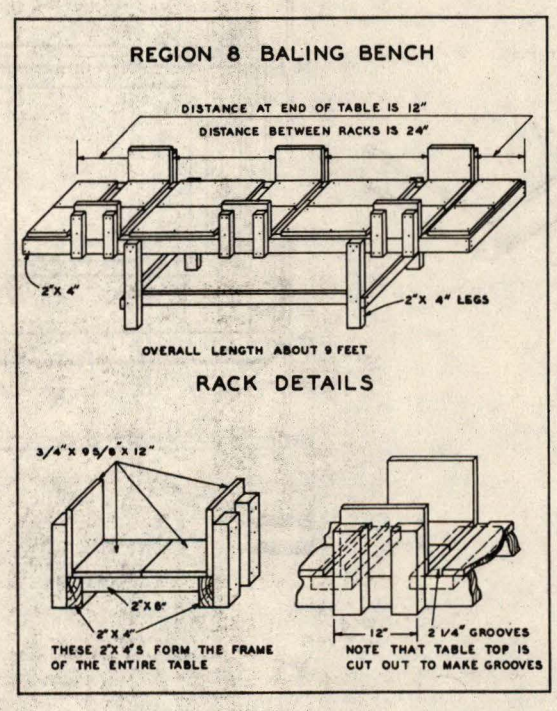
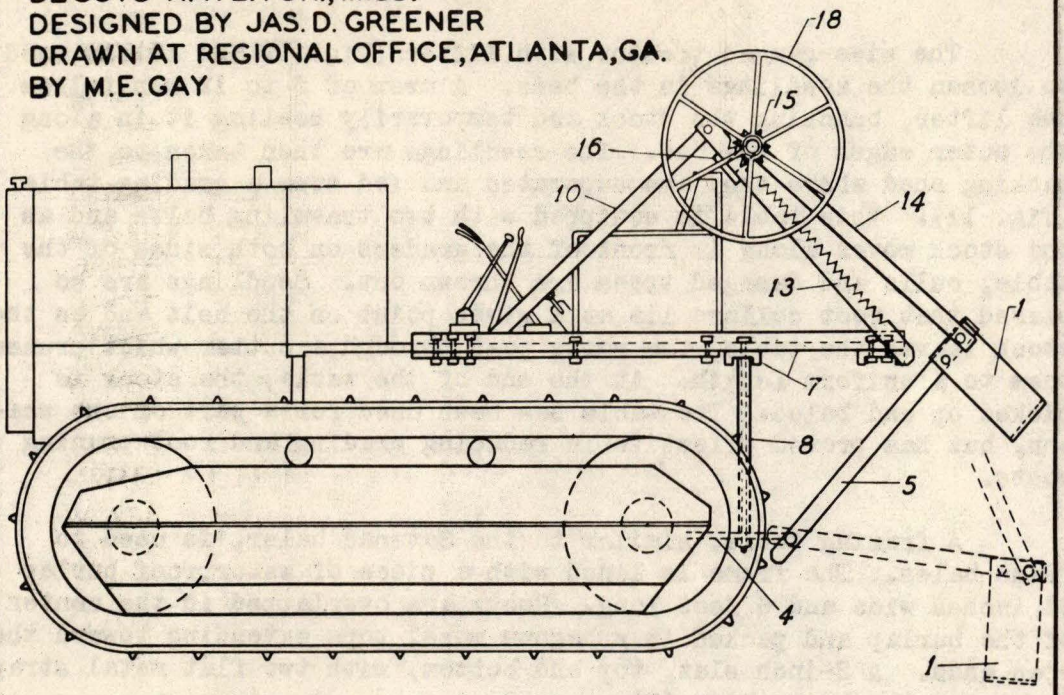
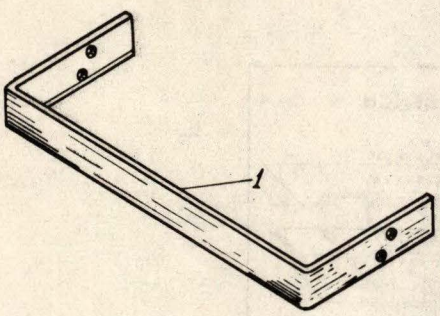

REGION 8 BALING BENCH
DISTANCE AT END OF TABLE IS 12"
DISTANCE BETWEEN RACKS IS 24"
2"X 4"
2"X 4" LEGS
OVERALL LENGTH ABOUT 9 FEET
RACK DETAILS
3/4"X 9 5/8"X 12"
2"X 8"
2"X 4"
THESE 2"X 4"S FORM THE FRAME OF THE ENTIRE TABLE
12"
2 1/4" GROOVES
NOTE THAT TABLE TOP IS CUT OUT TO MAKE GROOVES

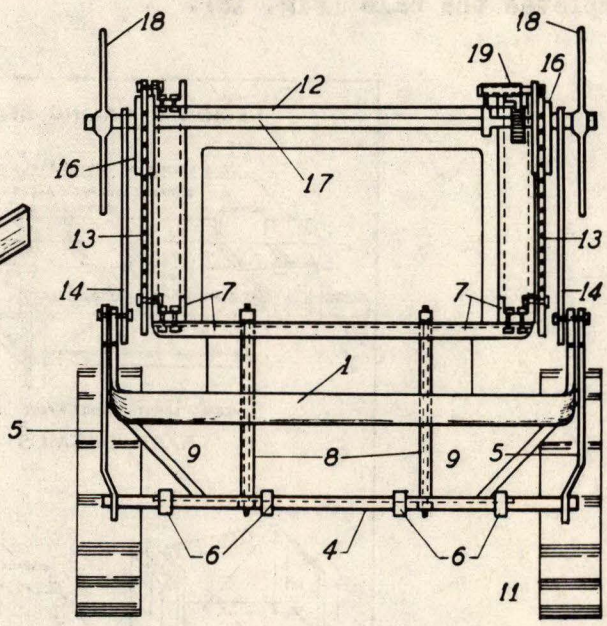
Figure 12.

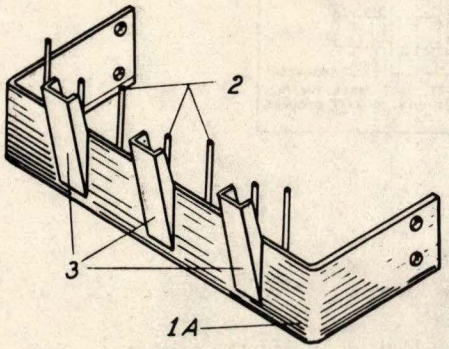
TREE LIFTER

W.W. ASHE NURSERY
DE SOTO NATL. FOR., MISS.
DESIGNED BY JAS. D. GREENER
DRAWN AT REGIONAL OFFICE, ATLANTA, GA.
BY M.E. GAY









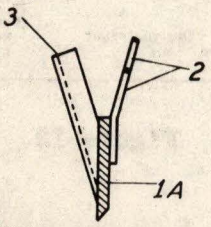


FIG. 9

TREE LIFTER SPECIFICATIONS

1. Lifter blade
2. Soil breakers
3. Landslides
4. Lower drawbar plate
5. Blade supports
6. Drawbar plate clamps
7. Frame base members
8. Frame supports
9. Angle braces
10-12. Superstructure frame members
11. Lifting blade shaft
13. Gear rack
14. Lifting blade arms
15. Pinion wheels
16. Gear guides
17. Gear shaft
18. Depth regulating wheel
19. Rachet dog and wheel

Note: Shear bolts are used to attach the cutting blade to the blade supports which protect the machine from serious damage when the cutting blade strikes solid objects.

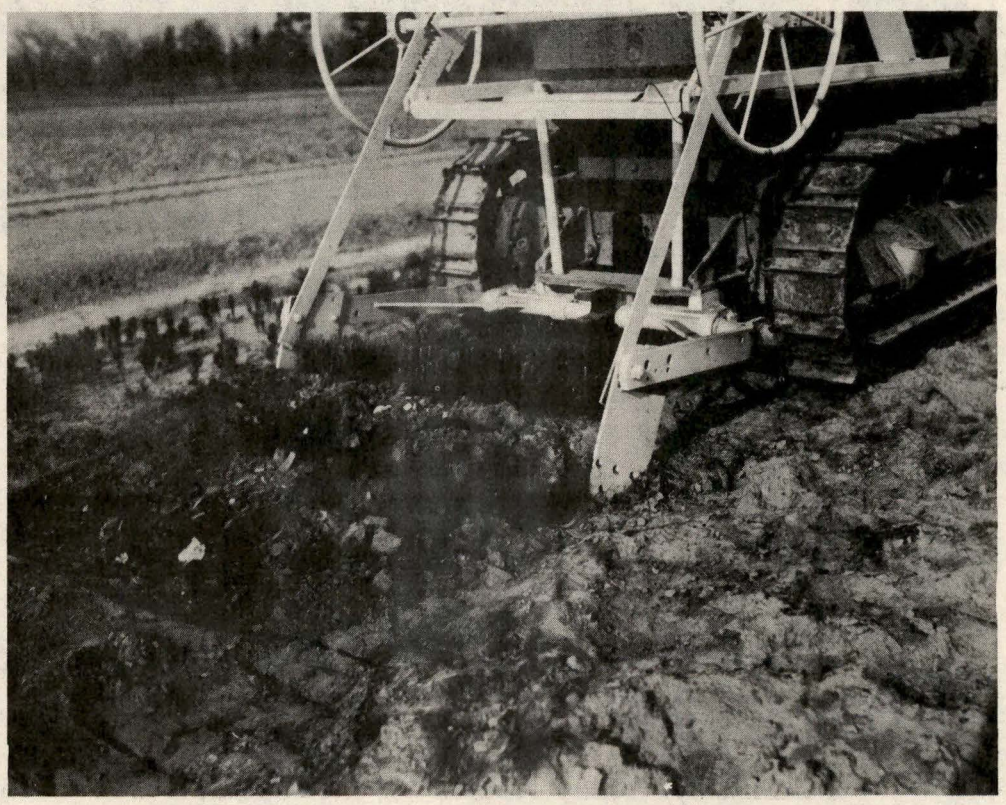


Figure 10.

TREE LIFTER

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EXPERIMENT STATION

Figure 11.

GRADING TABLE WITH TRAVELING BELTS

No stock is tied in bundles except that designated for small planting jobs where the bales are broken and the stock held in field heel-in beds at the camps. It is customary to gear the speed of planting to an output which will permit a fresh supply of planting stock at all times, eliminating the necessity for extra handling. Bales are taken to the crews in the field before being broken and the stock is placed directly in planting trays.

A flat metal strap similar to that manufactured by the Signode Steel Strapping Company, Chicago, Illinois, is superior to wire ties. Bales vary in size, depending on the species and the stock. A uniform length of cut wire makes it necessary to discard from 6 to 12 inches of wire on some bales. Metal strapping is cut the exact length needed without any waste. Time studies indicate that bales can be tied faster with metal straps.

The size of the stock-distribution crew at the nurseries must vary with the rate planting crews need stock. The organization permits wide flexibility of output up to 750 M per day. Under normal demands of 450 M to 550 M per day, a crew of 45 men will handle the work without difficulty. The size of the crew needed for a given output per day varies, contingent upon the species. Longleaf pine, for example, owing to its greater size, requires a longer time to handle in all of the operations. Approximately 1,500 trees of this species are packed in a bale, compared to 2,500 to 3,000 for slash, loblolly, and shortleaf pine. A bale of stock weighs from 75 to 100 pounds.

LOADING BALED STOCK FOR SHIPMENT

It is obvious that further refinement of nursery technique and development of machinery will produce better stock at decreased cost. Peak work loads which accompany large scale production, demand a certain amount of mechanization wherever hand labor is a large item of expense.